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ABSTRACT

The relationship between auditory learning via rate modified speech and the learner's relative degree of field dependence/independence was investigated. Eighty graduate students were assigned to groups using materials consisting of either normal--150 words-per-minute (wpm), compressed (250 wpm), or one of two expanded (either 120 or 90 wpm) audiotape versions of the Dwyer instructional script on the human heart and the related evaluation instruments. Results generally indicated that the normal groups scored higher than all other groups, but only significantly so in the 150 wpm versus 90 wpm comparisons for the terminology and comprehension tests. In most cases, neither the compressed or 120-wpm expanded versions resulted in significantly improved achievement. The 90-wpm group achieved significantly less. Field dependence was not significantly related to comprehension of material presented at different rates, though field dependent subjects generally scored lower than field independent learners on the expanded versions. A 29-item reference list is included. (Author/LMM)

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THE INTERACTION OF COGNITIVE STYLE AND AUDITORY LEARNING VIA RATE MODIFIED SPEECH (COMPRESSED AND EXPANDED)

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ABSTRACT

The purpose of this study was to investigate the relationship between auditory learning via rate modified speech and the learner's relative degree of field dependence/independence. Research related to the cognitive style of field dependence/independence suggests that the ability of field independents to impose structure upon information may facilitate the processing of auditory information to a greater degree than is possible for field dependent individuals when information is presented at varying rates of speed. Such research may also imply that conceptual density is a more realistic variable for study than is absolute word rate. The population consisted of 80 graduate students. Materials used consisted of normal, compressed and expanded versions of the Dwyer Heart script and the related evaluation instruments. Subjects were assigned to normal rate, compressed rate or one of two expanded rates. After listening to their respective treatments, students were administered the four achievement tests. Analysis of variance procedures and regression analysis were applied to the data.

Purpose

The purpose of this study was to further investigate the relationship between auditory learning via rate-modified speech and the learner's relative degree of field dependence/independence. Considerable research has investigated the comprehension of verbal materials presented by means of compressed or rate controlled speech(Duker, 1974). A comprehensive review of this research (Olson and Berry, 1982) indicated, however, that limited research has focused on the interaction of rate-controlled speech comprehension and various learner aptitudes or perceptual/cognitve styles. Furthermore, such research has given little consideration to the relationship between content complexity and presentation rates. Such research would provide (1) a means whereby a clearer understanding of auditory information processing could be achieved and (2) clarification of the relationship between learner cognitive style and conceptual density.

Rate-Modified Speech

In an everchanging society with an increasingly rapid pace, it becomes more important for an individual to acquire knowledge and information in the most efficient and expedient manner. This imperative is compounded by the fact that individuals learn at different rates. Since time spent in instruction is an important factor in maximizing instructional efficiency, technology has provided various means of altering recorded speech so that the instructor or student may adjust the rate of spoken presentation to suit his needs. This technique has been generally referred to as rate controlled speech or "Compressed Speech." Silverstone (1974) described this method of rate control as the

"...reproduction of an original recording in which the word-per-minute ratio is changed to a slower or faster rate of speech without eliminating the pitch or natural quality of the voice." Silverstone (1972) describes this technique as the process by which consonant sounds are maintained as in the original production, vowel sounds are reduced and pauses are eliminated as often as possible.

Substantial research has focused on both intelligibility and comprehension of rate-modified speech. Intelligibility refers to the extent that one is able to repeat information which was presented or to discriminate what one has heard. Comprehension refers to the ability to extract knowledge or information from what one has heard, usually by completing an objective test. Generally, no significant differences have been found between normal and compressed modes in terms of comprehension or intelligibility at rates up to 250 words-per-minute (Foulke, 1966, 1967). Foulke (1971) suggested that this implies a working, auditory processing limit of 275 words-per-minute.

These findings have, however, been questioned in studies by Adelson (1975) and deHaan (1977). In a comprehensive study, Adelson (1975), utilized hour long lectures rather than short passages, presented as rates of 175 and 275 words-per-minute. The researcher suggested that shorter passages such as those used by earlier researchers do not adequately assess a listener's overall comprehension. Findings of the study indicate that the length of stimulus materials is a critical factor. The traditional measures of intelligibility and comprehension were also investigated by deHaan (1977) in an attempt to determine if an individual's self-selected rate threshold could be used as a measure of

either variable. Results indicated that an individual's relative threshold is an extremely reliable indicator of compressed speech intelligibility but not of comprehension.

Foulke (1968b) reported that, with word rates ranging from 125 to 400 words per minute, comprehension was found to be adequate until the word rate exceeded 250 words-per-minute. As the word rate rose higher, the level of comprehension decreases in an inverse proportion. Foulke hypothesized that adequate processing time is needed for perception of words in order for comprehension to occur. If processing time is reduced, a decrease in comprehension results. Lost processing time was indicated to be a contributing factor in the level of comprehension. Hausfeld (1981) presented strong evidence for a working memory processing limit of approximately 275 words-per-minute.

This research did not focus, however, on the affect that expanded speech may have on intelligibility and comprehension. Since a slower rate of speech permits increased processing time, reducing the word-per-minute ratio could allow the listener a means by which auditory information could be processed more fully. Speech expansion is a technique which has been applied to situations where additional processing time is necessary. Law enforcement has found this use to be practical in situations where a dispatcher must understand or interpret an hysterical telephone call or a foreign accent. Expanded speech allows the listener more processing time to decipher what was said (The talk of the town, 1978).

Little empirical research has focused specifically upon the use of expanded speech for general instructional purposes. Since it is frequently a goal to minimize the learning time necessary for acquiring

information, expanded speech has not provided the most efficient means to attain this goal. However, if the information to be presented is not of a general instructional nature but rather highly technical or complex, expanded speech may provide additional processing time to more effectively acquire the information. Thus, expanded speech may prove to be a more desirable presentation rate for particular learning tasks.

It should be noted that current devices used for production of expanded speech have no provision for pitch control. Therefore, the resultant messages tend to be lower in pitch and somewhat distorted. According to the manufacturers of such equipment (VSC Corp.) this distortion does not appear to be deleterious to the comprehension and intelligibility of the material.

Characteristics of the message

Foulke (1968a) indicated that in measuring comprehension, there are two groups of factors which must be taken into consideration: (1) organismic features and (2) characteristics of the signal. Organismic factors include age, sex, intelligence and previous experience with the subject. Characteristics of the signal are concerned with word rate, method of compression and rate of occurrence of the speech sounds.

Relatively few researchers have devoted adequate attention to the characteristics of the message itself. This third area for consideration includes readability, complexity of information and the relative density of ideas or concepts.

Substantial research has focused on both intelligibility and comprehension of time-compressed speech. Generally no significant differences have been found between normal and compressed modes in terms of compre-

hension or intelligibility at rates up to 250 words per minute (Foulke, 1966,1967). These findings have, however, been questioned by other studies that have examined additional variables that may influence the existing 250 word per minute threshold.

One methodological problem inherent in much of this research work is that they used a variety of recorded messages which did not take into account the specific learning objectives or tasks and the complexity of information. The efficiency index of Fairbanks used in past studies assumed that all passages used were of equal difficulty and importance. Factors such as the length of the stimulus materials, density of ideas, items learned and not learner, and the difficulty of items learned and not learned were not considered (Adelson, 1975). Other research suggests that regardless of the speaking rate utilized, increasing the difficulty of the stimulus material results in a reduction of the amount of material that is comprehended (Spicker, 1963). Grammatical complexity has also been shown to have an inverse effect on the amount of comprehension of compressed material (Reid, 1968). The type of information used has an effect on comprehension and may also represent related but different aspects of listening comprehension. Regardless of the types of information, the threshold for word rate may be lower than what was originally identified (Rossiter, 1971). A listening threshold has been found to be a measure of intelligibility but not comprehension. These thresholds are consideredto be sensitive to individual differences and reflect some temporal limit of information processing (deHaan, 1977). Consequently, little generalizability from these findings is possible.

Cognitive Style: Field Dependence/Independence

Cognitive styles have been defined by Kogan (1971) as the individual variation in modes of "apprehending, storing, transforming and utilizing information." Ragan (1978) further stated that cognitive styles are "psychological dimensions" which reflect the individual differences for the manner of receiving, processing and utilizing information. Witkin, Moore, Goodenough and Cox (1977) described the characteristics of cognitive styles as: (1) cognitive styles deal with the "form" rather than "content" of cognitive activities, (2) cognitive styles are generally considered stable over time, and (3) cognitive styles are "bi-polar" unlike intelligence or other psychological variables.

One cognitive style which has attracted much research attention has been that of field dependence/independence, identified by Witkin, Oltman, Raskin and Karp (1971). Simplistically, field dependence/independence has been described as the extent to which an individual can disembed a figure from a ground. This perceptual aptitude is, however, indicative of a much more pervasive cognitive ability which enables the field independent individual to impose structure upon perceived information and then use this structure to more efficiently process and store the information. This perceptual ability has been documented extensively by Karp (1963) and Goodenough (1976). Generally, the factor of field dependence/independence is measured by either the Rod-and-Frame Test or one of a number of Embedded Figure Tests (Embedded Figures Test, Childrens Embedded Figures Test, Group Embedded Figures Test). All of these instruments rely upon the visual perceptual system and consequently have most frequently been employed in investigation of visual learning

variables. Goodenough (1976), however, suggests the much broader application of these instruments.

Orientation of the Present Study

The general redundancy in language, identified by Shannon and Weaver (1949) suggests great similarities between the auditory perceptual field and the visual perceptual field. In listening to an auditory message, the perceiver must separate out or disembed relevant from irrelevant information then further restructure this information for storage. It would appear then, in terms of auditory learning, that the factor of field dependence/independence would operate on the listener's ability to distinguish and organize the relevant auditory cues and terms. If this rationale isindeed accurate, then field independent individuals could be expected to demonstrate greater ability in imposing such a structure and hence, shouldperform better than field dependent individuals. When the rate of information is increased, as in the case of compressed audio messages, this difference could be expected to increase even further.

According to Flaherty (1979) field independent learners are more capable than field dependent learners of listening for meaning because they can concentrate on the content of the message moreso than the rate of presentation. If field independent learners are capable of extracting more content from a compressed presentation, then it may be concluded that they are also capable of gaining more information from a compressed presentation.

With respect to expanded speech, little research has focused on this aspect of rate-modified speech because the slower rates have had little apparent value in improving instructional effectiveness. However,

the stimulus materials used in previous research efforts have had little or no standardization. The question of idea or information density has also not been addressed to any great detail. When complex information containing a substantial amount of detail with little redundancy is presented at a compressed rate of speed, the result cannot be compared with a passage of less complex information presented at the same accelerated rate. Studies in rate-modified speech thus far have mainly concentrated on the rate of presentation and not the varying amounts of information or idea density presented in different passages. Perhaps for more complex material that contains many items of information a greater amount of processing time is essential to process and understand what is presented aurally. This may be further compounded by the real possibility that individuals who differ in their relative degree of field dependence/independence may also differ in their processing styles or abilities. Differences in idea or information density may also have an effect on how well listeners can comprehend the spoken material.

A second, yet related factor has been discussed in the literature on compressed speech, that of utilizing reliable and valid instruments for the evaluation of listener comprehension. Until the present, no standardized instruments have been developed, and those which had been developed represented a global measure of a variety of learning tasks. Work done by Rhetts (1974) suggest that learning research should also focus on the specific learning task being presented. Such a charge would imply that specific learning tasks presented via auditory channels be evaluated using instruments designed to measure achievement of each of those specific tasks. For this reason, a part of the research and

evaluation materials developed by Dwyer (1967, 1972) were employed in this investigation. The evaluation instruments incorporated in this package allow the researcher to evaluate learner achievement relative to four different learning tasks or objectives: drawing or spatially restructuring information, terminology or recall of specific information, identification or spatial analysis and comprehension or interrelating information. In addition, a total test measures overall achievement on all tasks. The use of such materials would seem to represent a more precise method of evaluating achievement or comprehension* of information via the auditory mode.

Method

The stimulus materials used in the study consisted of four audio tapes produced from the 2000 word instructional script on the human heart developed by Dwyer (1967, 1972). This script was recorded by a professional narrator at an average rate of 150 words per minute. The rate was selected as the normal or control rate because it is generally considered to be the average speed used by newcasters. A compressed version at 250 words per minute and two expanded versions of 120 and 90 words per minute were subsequently produced by use of the Variable Speech Control Module (VSC Corporation).

The five achievement test developed by Dwyer (Drawing Test, Terminology

*Note: The term comprehension as used in previous research relating to compressed speech should not be confused with the term identifying the Comprehension Test developed by Dwyer. The term as used by Dwyer refers specifically to the ability to "use information to explain some other phenomenon" (Dwyer 1972) whereas, the general term "comprehension refers to a more generalized ability which could interchangeably be called learning or achievement.

Test, Identification Test, Comprehension Test and Total Test) to compliment the instructional script were employed as evaluation instruments. In addition, the Group Embedded Figures Test developed by Witkin et al (1971) was used to determine the relative degree of field dependence/independence.

The population for the study consisted of eighty graduate students. Care was taken to exclude any individuals having had prior, formal training in medicine, physiology or anatomy as well as any subjects trained in Cardio-Pulmonary Resuscitation (CPR).

Based upon the results of Witkin's Group Embedded Figures Test, subjects were randomly assigned to either the control (normal rate, 150) or the experimental (compressed, 250 wpm or expanded, 120 and 90 wpm) groups. This factor represents a continuous variable, ranging from 0 to 18. Exact cutoffs for the extremes (high-field independent or low-field dependent) are not clear and are generally considered relative to the population being tested. Based upon previous research conducted on a similar population, cutoffs of 11 and 15 were established. Subjects falling at 11 or below were considered field dependent and subjects scoring at 15 or above were considered field independent. To avoid the statistical problem associated with three level blocking described by Cronbach and Snow (1977), only the extreme groups (field dependent/ field independent) were included in the study.

Groups of four students (one control and three experimental) were seated at a four carrel listening post and listened to their respective versions of the instructional script through individual head phones. Immediately following the audio presentation, each subject completed the four achievement tests.

Data Analysis

The study involved an ATI research design with two levels of the cognitive style variable (field dependence/independence) X four levels of the treatment variable (normal-150 wpm, compressed-250 wpm, expanded-120 wpm, expanded-90 wpm).

Data collected were first analyzed via a two-way analysis of variance procedure. Subsequently, regression analysis techniques were used to test for uniformity of regression slopes.

Findings

Two-way ANOVA's were performed on the scores obtained from each of the four achievement tests as well as on the Total Test scores. The results of these analyses are presented in table 1.

Table 1

Summary of Analysis of Variance Results (n=80)

Source	Drawing Test		Terminology Test		Identification Test		Comprehension Test		Total Test	
	F	P	F	P	F	P	F	P	F	P
Cog. Style (C)	1.27	.263	0.19	.662	0.72	.398	0.99	.322	0.94	.336
Treatment (T)	0.77	.514	3.54*	.019	0.69	.562	3.43*	.022	2.03	.117
C X T	1.71	.172	0.43	.729	0.44	.725	1.47	.231	0.52	.670

*Significant at the .05 level

Significant main effects for treatments were produced for the Terminology and Comprehension tests. Application of the Scheffé procedure for pair-wise comparisons indicated that the normal (150 wpm) group was,

in both cases, superior to the expanded (90 wpm) group. No interaction or other main effects were found to be significant.

Regression analyses were used to determine if relationships existed between the cognitive styles of the subjects and their scores on the achievement tests. Table 2 shows the results of these analyses.

Table 2

Analysis of Variance of Regression Coefficients for Differences in Intercept and Slopes between Cognitive Styles and Treatments for Achievement Scores on each Test

	F	p	R^2
Drawing Test	1.07	0.390	0.026
Terminology Test	2.12	0.061	0.005
Identification Test	0.57	0.748	0.005
Comprehension Test	1.91	0.090	0.007
Total Test	1.23	0.302	0.013

Results of these analyses showed the interaction of the slopes to be not significantly different. The cognitive style of the subjects explained only 2.6, .5, .5, .7 and 1.3 percent of the variance respectively, making the variable a poor predictor of achievement on the tests.

Discussion and Conclusions

Results generally indicated that the normal rate groups scored higher than all other treatments, however, to a significant extent only in the comparisons of the normal-150 wpm vs. expanded-90 wpm for the Terminology and Comprehension Tests. It would appear, that in most cases, neither the compressed or expanded-120 wpm versions resulted

in significanly improved achievement. The only group which achieved significantly less was the group which experienced the greatest degree of expansion. Such a finding would seem to directly contradict the sugesstion made earlier in this paper, that complex information, when given slower presentation rates, should result in improved achievement. This was obviously not the case, but these findings may be more directly attributable to two extraneous factors which are effects of the expansion process itself rather than due to the actual rate of expansion. These factors include (1) listener boredom and fatique and (2) pitch distortion due to the slowed rate. The first of these was observed frequently among subjects receiving the expanded version, and particularly the 90 wpm version. Apparently the slowed presentation of the highly technical information induced a degree of boredom resulting in loss of attention and concentration. The second factor, that of message distortion was readily apparent, both during the experiment as well as being cited by subjects after they completed the project. No provision is made in the design of the speech compression/expansion module to correct the pitch distortion caused by slowing down the tape, such as is done during speech compression. At slight rates of expansion, this distortion may not be a significant factor, but when expansion is carried out to the degree used in this study (90 wpm), extreme distortion occurs thereby affecting the intelligibility of the message as well as comprehension.

The variable of field dependence did not relate significantly to individuals' comprehension of material presented at different rates such as was found by Olson and Berry (1983). Although results were not

statistically significant, field dependent subjects generally scored lower on the expanded versions than did field independent listeners. In addition, the normal speed group demonstrated the same reversal of mean scores (field dependents scoring higher than field independent) which was observed by Olson and Berry (1983). Such a finding, again while not of statistically significant magnitude, should be further investigated. This reversal may suggest that field dependent individuals, when presented with a more global or spatial task such as required by the Drawing Test, tend to demonstrate higher achievement and surpass their field independent counterparts. It should be remembered however, that this effect was observed only on the normal presentation rate group.

The findings of this study strongly suggest that further research be conducted to confirm or disconfirm the hypothesis that more complex or technical information requires a slower presentation rate to facilitate optimum achievement. Research should further focus on the question of intelligibility and listener boredom as they relate to learning from expanded materials. Technical correction of the pitch distortion associated with expanded speech should be investigated.

It is also apparent that conclusive proof has not been presented regarding the instructional effectiveness of auditory materials presented at varying rates of compression and expansion to individuals who differ in their relative degree of field dependence.

Similarly, research should further investigate these factors as they relate to the effectiveness of rate-modified instruction presented via both auditory and visual modes simultaneously.

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